Health-care worker mortality and the legacy of the Ebola epidemic

The recent outbreak of Ebola in West Africa will leave a legacy significantly deeper than the morbidity and mortality caused directly by the disease. Ebola deaths have been disproportionately concentrated among health personnel. By May, 2015, 0·02% of Guinea's population had died due to Ebola, compared with 1·45% of the country's doctors, nurses, and midwives. In Liberia and Sierra Leone, the differences are more dramatic, with 0·11% and 0·06% of the general population killed by Ebola versus 8·07% of the health-care workers in Liberia, and 6·85% in Sierra Leone.[1–4] The fact that health-care workers are at greater risk of contracting Ebola will exacerbate existing skill shortages in countries that had few health personnel to begin with.

We modelled how the loss of health-care workers—defined here as doctors, nurses, and midwives—to Ebola might affect maternal, infant, and under-5 mortality in Guinea, Liberia, and Sierra Leone, with the aim of characterising the order of magnitude of likely effects, not providing specific predictions. We combined data on: (1) health-care worker deaths from Ebola;[1] (2) the stock of health-care workers pre-Ebola;[5] (3) maternal, infant, and under-5 mortality rates for each country, pre-Ebola;[2] and (4) coefficients of health-care worker mortality, which capture the relation between health-care workers in a given country and different mortality rates (ie, maternal, infant, and under-5 mortality).[3]

For each of the three countries, we first calculated how many doctors, nurses, and midwives combined have died due to Ebola per 1000 of the population. We multiplied each pre-Ebola mortality rate (maternal, infant, and under-5) by 1 minus this fraction, multiplied by the health-care worker mortality coefficient. We then translated this figure into the percentage change in mortality relative to pre-Ebola rates (appendix).

We constructed bounds based on the 95% CIs of the estimated coefficients of health-care worker mortality. These incorporate the estimation uncertainty associated with the health-care worker mortality coefficients and the pre-Ebola mortality rates, under the assumption that the latter uncertainty is constant across countries and over the period between the estimation of the health-care worker mortality coefficients (2006) and the present (2015). However, we were unable to account for the uncertainty surrounding the measurement of health-care worker mortality owing to a lack of data.

As of late May, 2015, Guinea, Liberia, and Sierra Leone, respectively, had lost 78, 83, and 79 doctors, nurses, and midwives to Ebola. The largest effects of these health-care worker deaths for all three countries were on maternal mortality (table), namely increases of 38% (95% CI 26–50) in Guinea, 74% (51–97) in Sierra Leone, and as large as 111% (76–145) in Liberia, relative to pre-Ebola rates. Estimated effects on infant and under-5 mortality ranged from an increase of 7–20% and 10–28% across countries, respectively. However, in both of the latter cases the health-care worker mortality coefficients used were not statistically significant in the original study[3] and the range between the upper and lower bounds of the 95% CIs includes a zero effect (table).

Combining these estimates with the most recent population numbers and rate of livebirths in each country pre-Ebola[2] suggests that an additional 4022 women would die per year in childbirth as a result of doctors, nurses, and midwives lost to Ebola. This would bring the countries back to rates of maternal mortality last seen in 2000 in Guinea and Sierra Leone, and 1995 in Liberia.[2]

These mortality estimates have limitations. The model's use of cross-country mortality coefficients assumes that the effect of health-care worker supply on maternal, infant, and under-5 mortality in Guinea, Liberia, and Sierra Leone is similar to the cross-country average and has not changed since those coefficients were estimated. This work further assumes that unmeasured elements of health systems (such an overall measure of quality), associated with both health-care worker density and mortality, are not driving the result. Data limitations make it difficult to account for these unmeasured factors,

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	Doctors, nurses, and midwives			Maternal mortality ratio (per 100 000 livebirths)			Infant mortality rate (per 1000 livebirths)			Under-5 mortality rate (per 1000 livebirths)		
	Stock pre-Ebola	Stock post-Ebola	% change	Pre-Ebola (2013)	May 2015	% change (95% CI)	Pre-Ebola (2013)	May 2015	% change (95% CI)	Pre-Ebola (2013)	May 2015	% change (95% CI)
Guinea	5395	5317	–1%	650	897	38% (26 to 50)	65	69	7% (–2 to 15)	101	110	10% (–2 to 21)
Liberia	1029	946	–8%	640	1347	111% (76 to 145)	54	64	20% (–4 to 43)	71	91	28% (–5 to 61)
Sierra Leone	1153	1074	–7%	1100	1916	74% (51 to 97)	107	121	13% (–3 to 29)	161	191	19% (–4 to 41)

Data are from author calculations based on Ebola mortality data from WHO,[1] population and maternal mortality data from World Development Indicators,[2] and health worker-mortality coefficients from Speybroeck et al.[3] Data on pre-Ebola stock of health workers is for the most recent years available for each country: 2004 (nurses and midwives) and 2005 (doctors) for Guinea, 2008 for Liberia, and 2010 for Sierra Leone.

Table: **Effects of health-care worker deaths from Ebola on maternal, infant, and child mortality**

but one may consider that health-care workers are a crucial element of all other parts of an effectively functioning health-care system. However, these numbers demonstrate the potentially sizeable legacy that Ebola will leave.

Ebola has weakened already fragile systems, and it should be the catalyst to strengthen the systems far beyond their pre-Ebola levels. Indeed, to reach the minimum 80% health coverage targeted by the Millennium Development Goals, 43 565 doctors, nurses, and midwives would need to be hired across the three countries. Our estimates suggest that substantial investment in health systems—and specifically in the health workforce—is urgently required not only to improve future epidemic preparedness and meet basic needs, but also to limit the secondary health effects of the current epidemic owing to the depletion of the health workforce.

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1 WHO. Health worker Ebola infections in Guinea, Liberia and Sierra Leone: a preliminary report. Geneva: World Health Organization, 2015. http://www.who.int/csr/resources/publications/ebola/health-worker-infections/en/ (accessed May 22, 2015).

2 World Bank. World development indicators 2015. http://data.worldbank.org/data-catalog/world-development-indicators (accessed May 22, 2015).

3 Speybroeck N, Kinfu Y, Poz MD, Evans D. Reassessing the relationship between human resources for health, intervention coverage and health outcomes. Geneva: World Health Organization, 2006. http://www.who.int/hrh/documents/reassessing_relationship.pdf (accessed May 22, 2015).

4 WHO. Ebola situation report, 20 May 2015. Geneva: World Health Organization, 2015. http://apps.who.int/ebola/en/current-situation/ebola-situation-report-20-may-2015 (accessed May 22, 2015).

5 WHO. Health workforce density per 1000 population. http://apps.who.int/gho/data/node.main.A1444 (accessed May 22, 2015).